

WHAT IS CLAIMED IS:

1. An electrochromic element having a configuration that a reductive coloration layer and an oxidative coloration  
5 layer are arranged in a facing manner between which a solid electrolyte layer is intervened;

wherein said reductive coloration layer is composed of a material containing a tungsten oxide and a titanium oxide;

wherein said oxidative coloration layer is composed of  
10 a material containing a nickel oxide;

wherein a transparent intermediate layer composed of a metal oxide other than a nickel oxide or a metal or a composite comprising a metal oxide other than the nickel oxide and a metal as a main component is placed between said oxidative coloration  
15 layer and said solid electrolyte layer, and

wherein said electrochromic element has a gray color at the time of coloration.

2. An electrochromic element comprising a first  
20 electrode layer, a reductive coloration layer, a solid electrolyte layer, an oxidative coloration layer, and a second electrode layer laminated between two plate materials, and at least combination of a plate material at one side with the electrode layer of said two plate materials and said two  
25 electrode layers being made transparent;

wherein said reductive coloration layer is composed of

a material containing a tungsten oxide and a titanium oxide;

wherein said oxidative coloration layer is composed of  
a material containing a nickel oxide;

wherein a transparent intermediate layer composed of a  
5 metal oxide other than a nickel oxide or a metal or a composite  
comprising a metal oxide other than the nickel oxide and a metal  
as a main component is placed between said oxidative coloration  
layer and said solid electrolyte layer, and

wherein said electrochromic element has a gray color at  
10 the time of coloration.

3. The electrochromic element according to Claim 2,  
wherein both of said two plate materials and said two electrode  
layers are made transparent, the total of said element is made  
15 transparent in the thickness direction thereof; and said  
electrochromic element is placed on an optical axis of an  
imaging element of a digital camera as an element for adjusting  
exposure.

20 4. The electrochromic element according to Claim 2,  
wherein one combination of a plate material at one side with  
the electrode layer of said two plate materials and said two  
electrode layers is made transparent, and the electrode layer  
at the other side is made of a reflecting metal film to make  
25 up a reflectance-variable mirror.

5. An electrochromic element having  
a substrate,  
a first electrode layer formed on said substrate in a fixed  
manner,  
5 an oxidative or reductive coloration layer formed on said  
first electrode layer in a fixed manner,  
a solid electrolyte layer formed on said oxidative or  
reductive coloration layer in a fixed manner,  
a reductive or oxidative coloration layer formed on said  
10 solid electrolyte layer in a fixed manner, and  
a second electrode layer formed on said reductive or  
oxidative coloration layer in a fixed manner, at least one of  
said first and second electrode layers being made transparent,  
wherein said reductive coloration layer is composed of  
15 a material containing a tungsten oxide and a titanium oxide;  
wherein said oxidative coloration layer is composed of  
a material containing a nickel oxide;  
wherein a transparent intermediate layer composed of a  
metal oxide other than a nickel oxide or a metal or a composite  
20 comprising a metal oxide and a metal as a main component is placed  
between said oxidative coloration layer and said solid  
electrolyte layer, and  
wherein said electrochromic element has a gray color at  
the time of coloration.

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6. The electrochromic element according to Claim 5,

wherein said substrate is made transparent, said first and second electrode layer are each composed of a transparent electrode film, a transparent plate-form sealing member is conjugated with said second electrode layer via a transparent  
5 sealing resin, the total of the element is made transparent in the thickness direction thereof, and the element is placed on an optical axis of an imaging element of a digital camera as an element for adjusting exposure.

10           7.     The electrochromic element according to Claim 5, wherein said substrate is made transparent, said first electrode layer is composed of a transparent electrode film, said second electrode layer is composed of a reflecting metal film, and a sealing member is conjugated with said second  
15 electrode layer via a sealing resin to make up a reflectance-variable mirror whose front side is at the side of said substrate.

20           8.     The electrochromic element according to any one of Claims 1 to 7, wherein said reductive coloration layer is a film of a mixture comprising a tungsten oxide and a titanium oxide as main component or a film of a mixture comprising a tungsten oxide as a main component with a titanium oxide added thereto, and said oxidative coloration layer is a film comprising a  
25 nickel oxide as a main component.

9. The electrochromic element according to any one of Claims 1 to 8, wherein atomic number of tungsten contained in said reductive coloration layer is larger than atomic number of titanium.

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10. The electrochromic element according to any one of Claims 1 to 9, wherein the proportion of titanium atom in said reductive coloration layer relative to the total atomic number of tungsten atoms and titanium atoms is from 5 to 40%, preferably  
10 from 20 to 30%.

11. The electrochromic element according to any one of Claims 1 to 10, wherein said tungsten oxide comprises  $\text{WO}_3$  as a main component, said titanium dioxide comprises  $\text{TiO}_2$  as a main  
15 component, and said nickel oxide comprises  $\text{NiO}$  as a main component.

12. The electrochromic element according to any one of Claims 1 to 11, wherein said nickel oxide contains  $\text{Ni}(\text{OH})_2$ .

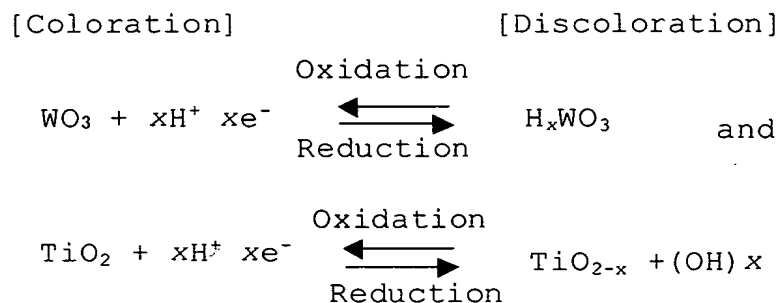
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13. The electrochromic element according to any one of Claims 1 to 12, wherein said reductive coloration layer is amorphous, and said oxidative coloration layer is crystalline, fine-crystalline or amorphous.

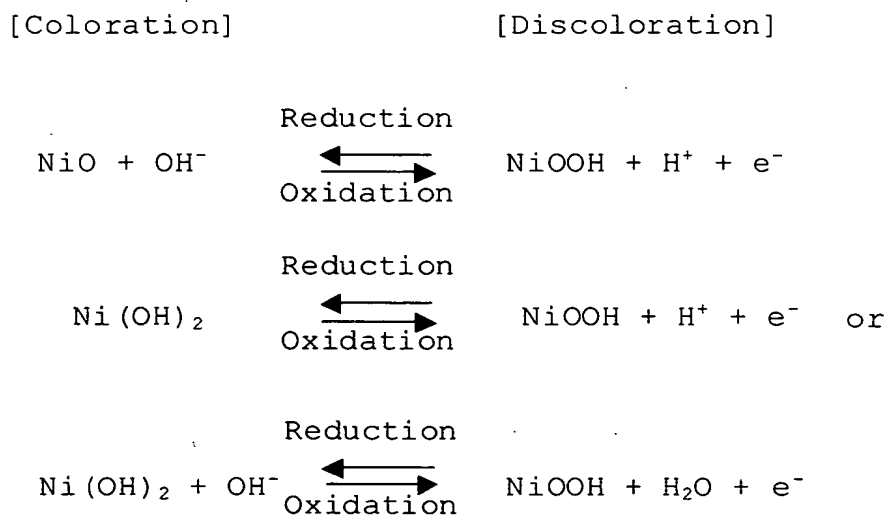
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14. The electrochromic element according to any one of

Claims 1 to 13, wherein said reductive coloration layer has the reaction represented by formulae:



and said oxidative coloration layer has the reaction  
 5 represented by formulae:



15. The electrochromic element according to any one of  
 Claims 1 to 14, wherein said reductive coloration layer contains  
 10 components of a film formed by a two-element deposition process  
 utilizing  $\text{WO}_3$  and  $\text{TiO}_2$  as starting materials, and said oxidative

coloration layer contains components of a film formed by a deposition process utilizing NiO as a starting material.

16. The electrochromic element according to any one of  
5 Claims 1 to 15, wherein the peak value at a time of coloration is not less 1.75 V, more preferably not less than 2 V, and not more than 3 V when both electrodes comprises transparent electrode films, and not less than 1V and not more than 1.8 V, when one electrode comprises a transparent electrode film and  
10 the other electrode comprises a reflecting film also serving as an electrode.

17. The electrochromic element according to any one of  
Claims 1 to 16, which is colorless at the time of discoloration.  
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18. The electrochromic element according to any one of  
Claims 1 to 17, wherein said metal oxide making up said intermediate layer comprises any one of SnO<sub>2</sub>, ZnO, In<sub>2</sub>O<sub>3</sub>, ITO, Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, TiO<sub>2</sub>, Sb<sub>2</sub>O<sub>5</sub>, and ZrO<sub>2</sub>, or a composite of two or more  
20 thereof as a main component.

19. The electrochromic element according to any one of  
Claims 1 to 17, wherein said metal oxide making up said intermediate layer comprises an electrically conductive metal  
25 oxide.

20. The electrochromic element according to any one of Claims 1 to 19, wherein said metal making up said intermediate layer comprises any one of Ag, Au, Cr, Al, and Pd or a composite of two or more thereof as a main component.

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21. The electrochromic element according to any one of Claims 1 to 20, wherein said metal oxide making up said intermediate layer contains no nickel oxide or if any contains in an amount of less than 0.02, preferably less than 0.01, on  
10 the weight base relative to the main component making up said intermediate layer.

22. An electrochromic element comprising a transparent intermediate layer composed of a metal oxide other than a nickel  
15 oxide or a metal or a composite comprising a metal oxide other than the nickel oxide and a metal as a main component is placed between an oxidative coloration layer containing a nickel oxide and a solid electrolyte layer.

20 23. The electrochromic element according to Claim 21, wherein said metal oxide making up said intermediate layer contains no nickel oxide or if any contains in an amount of less than 0.02, preferably less than 0.01, on the weight base relative to the main component making up said intermediate  
25 layer.



24. The electrochromic element according to Claim 22 or 23, wherein said metal making up said intermediate layer comprises any one of Ag, Au, Cr, Al, and Pd or a composite of two or more thereof as a main component.

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25. An electrochromic element comprising a transparent intermediate layer composed of a metal oxide other than a nickel oxide or a metal or a composite comprising a metal oxide other than the nickel oxide and a metal as a main component is placed  
10 between an oxidative coloration layer containing a nickel oxide and a solid electrolyte layer., said metal oxide making up said intermediate layer contains no nickel oxide or if any contains in an amount of less than 0.02, preferably less than 0.01, on the weight base relative to the main component making up said  
15 intermediate layer.

26. The electrochromic element according to any one of Claims 22 to 25, wherein said metal oxide making up said intermediate layer comprises any one of SnO<sub>2</sub>, ZnO, In<sub>2</sub>O<sub>3</sub>, ITO,  
20 Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub>, TiO<sub>2</sub>, Sb<sub>2</sub>O<sub>5</sub>, and ZrO<sub>2</sub>, or a composite of two or more thereof as a main component.

27. The electrochromic element according to any one of Claims 22 to 25, wherein said metal oxide making up said  
25 intermediate layer comprises an electrically conductive metal oxide.

28. The electrochromic element according to any one of Claims 22 to 27, wherein said oxidative coloration layer comprises a nickel oxide as a main component.

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29. The electrochromic element according to any one of Claims 22 to 28, wherein said nickel oxide contained in said oxidative coloration layer comprises NiO as a main component.

10 30. The electrochromic element according to any one of Claims 1 to 29, wherein said metal oxide making up said intermediate layer is  $\text{SnO}_2$  and the thickness of thereof is less than 70 nm.

15 31. The electrochromic element according to any one of Claims 1 to 30, wherein said solid electrolyte comprises  $\text{Ta}_2\text{O}_5$  as a main component.